
A PLEA FOR OBSERVATION OF THE HABITS OF FISHES
AND AGAINST UNDUE GENERALIZATION



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I have been requested to address the International Fishery Congress, but on account of the extensive programme provided for it brevity will be recognized as a virtue if not demanded as a requisite. I shall therefore confine my remarks to a plea for the presentation of much wanted information respecting the habits of fishes in general, but especially those which are the objects of pisciculture. Indeed such knowledge is a necessary prerequisite for successful pisciculture and should be made public in the interests of industry as well as of science. Nevertheless, essentials of some of our most esteemed fishes are scarcely known beyond a very small circle of pisciculturists. The crappie of America (*Pomoxis sparoides*) is a notable case. It is one of our best fresh-water fishes, but the accessible accounts of its habits are extremely meager and no account has been published of its sexual intercourse, the preparation of a nest, or the care of the eggs and young by the parent fish.

Too much care can not be given to the detailed observation of the economy of any fish, for differences between related species may exist which might be least foreseen. For instance, two silurids occur in Europe which are so near each other that they have been long nominally confounded; they are the common wels of central and eastern Europe and the glanis of Greece. Notwithstanding their great morphological similarity, they differ remarkably in their habits, for the wels takes no care of its eggs, while the male of the glanis exercises paternal supervision for a prolonged period. Why the statement that the two have been nominally confounded has been made will be explained later. One more example of contrast may be cited. One of the best known and most generally published accounts of parental care among fishes is that one, three quarters of a century ago (1828), attributed to the hassars (*Callichthys* or *Hoplosternum*) by Dr. John Hancock. Yet the species of a related genus (*Corydoras*) have quite different habits in general as well as in courtship and oviposition; no care is exercised over the eggs by either parent.

Fishes that do exercise parental care differ as to the manner in which it is shown and the length of time it is maintained. Most, if not all, of our centrarchids, for instance, protect their eggs, but there is a difference between species or genera otherwise. It was first declared some years ago (in 1903), by Prof. Jacob Reighard, that the black bass continues the care begun with the nest and new-laid eggs till the young fishes have acquired a considerable size, while sunfishes of the genera *Eupomotis* and *Lepomis* discontinue care after the eggs have been hatched.

Undue generalization has been exercised also in statements respecting the relative sizes of the sexes of fishes. A celebrated ichthyologist, in an "Introduction to the Study of Fishes," positively declared that "it appears that in all teleosteous fishes the female is larger than the male," and yet there are many exceptions to this statement. Indeed, in most fishes whose males are differentiated by marked secondary characters, so far as known the male is larger than the female. Even in some of our common cyprinids such is the case; the species of *Semotilus*, often miscalled "chub" or "horned dace," are examples. The males of those species are stone-rollers, thereby preparing a nest for the eggs. An undue generalization might be extended from the examples for it might be assumed that there was coordination between the size and the care-taking function. In contrast, however, the lumpsucker (*Cyclopterus*) confronts us; in this case the male is much smaller than the female. In fact, we are in much need of definite information as to relative sizes of fishes generally.

A common African fish, the boliti (*Tilapia nilotica*) of Egypt, has males larger than the females, and presumably many others of the same large family do likewise. In this case the males prepare a nesting place but the females act as nurses by taking their eggs into their mouths for incubation.

There is a tendency among almost all men to too great generalization and to an assumption that, because certain forms manifest special modes of behavior or action, others do so also. Thus, because the fishes that had been noticed by early observers did not take care of their eggs but left them after deposition and fertilization to unaided nature, it was assumed that all fishes were alike neglectful. Later, it was found that some forms did take charge of their eggs and then it was assumed that it was the females, simply because among mammals and birds the females do so. Our catfishes and sunfishes, for example, were discovered to care for their eggs, but the old observers invariably credited such care to the females. Meanwhile it was ascertained that it was really the males, only or chiefly, that assumed such charge, and as such was found to be the case also among the sticklebacks and various other fishes, the generalization was conceived that in the case of all fishes that care for their eggs it was the male that was the guardian.

This generalization was applied to the cichlids of Africa and Palestine and, in various accounts of the habits of the bolti and similar fishes, reputable writers, such as Günther and Lortet, especially credited the males with exclusive parental care. Subsequent dissections of the same species and other species observed by these naturalists revealed the fact that in all the cases in question the females took charge, taking their eggs in their mouths and caring for them and the newly hatched young until they had attained a considerable size. In fact, so far as the cichlids are concerned, numerous African species have now been examined, and for all of those so examined the females have been ascertained to be the egg-carriers. Let it not be assumed, however, that all the other cichlids take such care of the young and that all American species do so, as well as the African. Indeed, even now it is known that certain South American species provide for their eggs in nests made by heaping pebbles over their eggs or otherwise preparing the bottom, rather than by oral incubation. But more than this is not known and we are ignorant of the parts played by the respective sexes.

The tendency to undue generalization has been exhibited in a striking and even amusing manner in the case of two European fishes already referred to, the wels of Germany and the glanis of Greece. The wels had long ago been declared by many observers to exercise no parental care after deposition and fertilization of their eggs. It happened, however, that Aristotle, over twenty-two centuries ago, gave elaborate details of the glanis and the care taken of the eggs by the male parent. Instead of those accounts, which bore the impress of observation and truth on their face, serving as a check to identification, it was assumed by some of the greatest of modern ichthyologists, such as Cuvier, Valenciennes, and F. A. Smitt, that the wels and the glanis were of the same species; the Frenchmen declared that Aristotle's account "borders a little on the marvelous" and the Swede reechoed with the remark that "it is now regarded as dubious." Yet over half a century ago (1856) Agassiz declared that Aristotle was right and that the Aristotelian fish differed, not only specifically but generically, from the wels. Later, comparative descriptions and illustrations of the Grecian species were published; nevertheless the two continued to be confounded in Europe under the same name. But recently a new attitude has been assumed otherwise. At last it has not only been acknowledged that the facts recorded by Aristotle were credible, but assumed that what was true of the glanis must be true of the wels; in a reference to the species made by a distinguished French ichthyologist this year the wels ("l'enorme Silure d'Europe") is credited with paternal instinct and attention. Thus has generalization been carried to an extreme and assumption piled on assumption. One further assumption apparently was that because the glanis was not in a European

museum it could not be a distinct species, and another that the American authors were incompetent to determine the species.

It might be thought that related species would agree at least in the character of their eggs and oviposition, but exceptions to this also occur. A notable case is manifest among the clupeids. There are several species of the northern seas so closely related that they are associated by most ichthyologists except in America in the same genus—*Clupea*. Nevertheless there are remarkable differences between species in their eggs, as well as in the manner of depositing them. The typical herrings (*Clupea harengus* and *Clupea pallasii*) have opaque eggs destitute of oil globules, deposited in the sea in water of moderate depth and adhering in masses to foreign bodies at the bottom; the pilchards (*Clupanodon pilchardus*, etc.) have translucent eggs, buoyant by oil globules, and cast near the surface of the sea often quite far from land and there hatched; the shads (*Alosa* species) leave the sea and ascend rivers to deposit their eggs near or on the bottom in fresh water; the alewives and hickory shads (*Pomolobus*) are also anadromous and agree in most respects with the shads.

Another requisite, too often overlooked for the successful historian of a fish's habits, is that the species in question should be correctly identified or the means for identification furnished. Many instances might be given of interesting details of habits of animals worthless to science because the species are not recognizable. Only one such need be mentioned and that because it has recently come up for notice. Many years ago (in 1874) a French amateur naturalist, Carbonnier, published some remarkable details of the breeding habits of fish received from New York which he called "la Fondule (*Fundula cyprinodonta*, Cuv.)." I have been frequently appealed to for information as to the proper name of that fish. No such fish was described by Cuvier and apparently the Frenchman had been informed by some one, in an offhand manner, that it was a *Fundulus*—a cyprinodont—and had been satisfied with the suggestion and even misinterpreted the statement. In fact, the fish was not a cyprinodont at all, although having a considerable superficial resemblance to one, but an umbrid, the common *Umbra pygmaea* of New York. To this day, so far as published records show, Carbonnier is the only man who has succeeded in breeding this fish, but his record was long unusable because it was not known what fish he really had.

Another fault we must take care to guard against is the counterbalancing of a difficulty against a certainty. Many examples of this are to be met with in the history of the common eel. Several are still persistent.

The breeding resorts of the eel of northern Europe have been discovered within the last two years, thanks to the International Council for the exploration of the North Sea and the excellent work of Johannes Schmidt; they are in the ocean at "depths of at least about 1,000 meters (corresponding to a pressure

of ca. 100 atmospheres).” In other words, eels can not mature their gonads nor breed in fresh water, yet there are many persons to the present day who maintain that they must do so, because they can not perceive how eels could be found in ponds and waters isolated from rivers communicating with the ocean. There are many ways in which they might be diffused, but that need not concern the biologists; that they must have originated in the ocean is certain.

No eels which have once spawned have been found in fresh waters, but because large eels have been seen at some place pursuing an upward course, strenuous claims have been made that some do ascend rivers after spawning; here again we have a difficulty (but an extremely slight one) balanced against a counterfact.

We have still much to learn about our most common and longest-known species. The *Apogon imberbis* or *rex-mullorum* is a Mediterranean fish which had never been regarded as of much interest. Several years ago (1903), however, a French naturalist (L. Vaillant) found its own eggs in the mouth of the male of a related Caribbean fish (*Cheilodipterus affinis*) and quite recently the United States Deputy Commissioner of Fisheries (Hugh M. Smith) found also in the waters of the Philippine Archipelago a number of species exercising oral incubation. This present month (September 1, 1908) Dr. L. Plate records the discovery of a small species of the same group (*Apogonichthys strombi*) as a commensal of the large whelk known as *Strombus gigas*.

With these facts discovered respecting congeneric species, renewed observations should be made. It would be another example of the undue generalization which has been deprecated to assume that the Mediterranean fish agreed with its relatives in oral incubation—very much more that it was a commensal. It should be reexamined till something definite can be learned of its habits during the breeding season. Fishermen may often have found individuals with eggs in the mouth and assumed that they had been taken in as food, so that the fact of none of these fish having been recorded with such eggs is a matter of minor consequence. We would have reason for surprise if it should be found that the Mediterranean *Apogon* does not exercise oral incubation, and also if other species have commensal habits like the *Apogonichthys strombi*, but positive assumption is illegitimate in both cases.

The relationship of fishes to other animals is a subject which will repay future investigation, and search may be rewarded by many cases scarcely less expected than the parasitic habit of the *Apogon*. Certain tropical pomacentrids of the genera *Amphiprion* and *Premnas* use actinozoans for shelter; the butterfish of the American coast (*Poronotus triacanthus*) harbors during its early youth under the disk of a medusa, and so does also the scad (*Trachurus trachurus*) of Europe. Still more remarkable are the fierasfers which seek

shelter and home by obtruding into the posterior end of the abdominal cavity of holothurians.

Another subject that will furnish interesting cases is courtship among fishes. Many American fresh-water fishes furnish examples. The males become more or less brilliant and assume bright liveries for and during the spawning season and variously show themselves to the females; the best known species are the sunfishes (*Lepomis* and *Eupomotis*) of different kinds, but representatives of most or all families have their special modes of action. A still more elaborate courtship was observed a decade ago (1898) by Ernest Holt among sea fishes of the genus *Callionymus*.

One fact, too often forgotten, is that there is considerable individuality among fishes and that there may be exceptions to most general propositions. Species, for instance, may prefer certain food, but if they can not get such they will act very much like human beings—take what they can get. Yet our periodicals, monthly as well as weekly, are often charged with bitter controversies because one man makes an assertion respecting habits which is denied by another who asserts that the animal in question always has certain other habits. Both may be right in their observations but wrong in contending each that the other is wrong.

Such are a few of the many interesting phenomena manifested by fishes and such a few of the special exceptions to general propositions. No men are professionally in such excellent positions for observation of the habits of fishes as are pisciculturists, and, if they would, they could add greatly to our knowledge of their ways and means; that they should do so the scientific ichthyologist and the practical fisherman must alike hope.

I conclude with a recapitulation of some of the characteristics by which fishes are distinguished among themselves and which may direct attention to points overlooked or forgotten. Any biography of a fish that is wanting in attention to any of the characteristics indicated is to such extent incomplete.

SCHEDULE FOR OBSERVATION.

Specific characters:

- Adults.
- Sexual differences.
- Relative size.
- Length.
- Weight.

General behavior:

- Character of water preferred.
- Character of ground preferred.

General behavior—Continued.

- Manner of resting.
- Manner of swimming.
- Use of fins.
- Respiration.
- Association (in schools, etc.).

Feeding:

- Kind of food preferred.
- Manner of taking.

Feeding—Continued.

Time of taking.
 Abstinance during spawning season.
 Abstinance during cold periods.

Distribution:

General.
 Seasonal (summer, winter, etc.).
 Migration.
 Arrival.
 Departure.
 Route of travel.
 Relative appearance of sexes.
 Schooling.

Reproduction:

Age at maturity.
 Preliminary changes.
 Special male seasonal characters.
 Special female seasonal characters.
 Season of reproduction.
 Temperature of water.
 Preparation.
 Manner of sexual excitation.
 Nest-making.
 Parts assumed by sexes.
 Selection of place.
 Depth of water preferred.
 Manner of spawning.

Reproduction—Continued.

Frequency of spawning.
 Behavior of males and females meantimes.
 Disposition of eggs.
 Number of eggs.
 Period of incubation.
 Retardation or acceleration of incubation by temperature.
 Care of eggs.
 Care of fry.
 Period of care.
 Food of young.

Growth:

Development.
 Successive changes.
 Size and characters, first year, second year, third year, fourth year.

*Parasites.**Diseases.**Economical value:*

Value as food and otherwise.
 Manner of capture.
 Statistics.

Legends:

Beliefs or sayings connected with species.

DISCUSSION.

Prof. E. E. PRINCE (Canada). I feel again as if I ought to apologize for rising to speak, at the same time I am impelled out of a sense of gratitude to Doctor Gill, which all the younger workers in ichthyology and the students of fish and fisheries generally feel for one who is the Nestor of the science of fish and fisheries. It is a privilege which I think we shall long remember to have heard Doctor Gill on this occasion; and I think that on the principle of keeping the good wine to the last it was appropriate that Doctor Gill should come in even at the end of the programme. I may claim to be one of the younger workers, and I have always felt that Doctor Gill was one who gave credit to the young workers for anything they contributed to science.

I do not wish to trespass very long on the time of the congress, but I feel especially interested in Doctor Gill's reference to the development of the eel, because since I came to this congress I have received quite a long letter from Doctor Schmidt, of Copenhagen, asking about the movement of young eels in our Canadian waters, and I hope to be able to report, as indeed I have previously, certain observations of my own as to the migration of young eels up some of our Canadian rivers. Countless multitudes ascend in the summer, especially in August, and they surmount obstacles such as high falls.

The statement that one can never prophesy the characteristics of a fish as to its eggs and its young I know to be very true, and we should remember the warning which I think Sir Ray Lancaster, long ago, gave embryologists, that embryology was so full of surprises and wonders that we must never prophesy until we know. I remember, years ago, my own experience in regard to *Clupea sprattus*, for I felt as if all the herring family should deposit their eggs in a certain way, viz, on the sea bottom, because *Clupea harengus* did so; and I remember with great surprise finding that *Clupea sprattus*, the small sprat in European waters, deposited not only a pelagic or floating egg, but an egg of extreme delicacy. The egg of *Clupea sprattus* is the most delicate and most buoyant. This is surprising when one remembers the nonbuoyant eggs of the herring. Then, the fact that the smelt also deposits, like the Salmonidæ generally, not only a heavy egg, but an egg which is attached by a kind of pedestal to stones in brackish water, not a loose free egg, shows that we must investigate by actual observation and by actual study the character of the eggs and spawning peculiarities of every species.

Again, the fact that the male in some species and the female in others perform certain functions during the life of their young brood has a most interesting but a somewhat perplexing side. I remember only last summer, just a year ago, finding on the Pacific coast a fish which is well known, I am sure, to Doctor Gill, *Porichthys porissimus*, a very unprepossessing fish in appearance, but a fish which has the peculiar habit of sitting beside its eggs through development; and not only sitting by them and watching them, but singing to them, and as you walk along the beach you hear the peculiar cooing sound, or kind of croaking sound, which the parent fish makes when sitting by her brood and watching them. What the meaning is we can not surmise; but we find the fish singing to its young when they are actually attached firmly to the underside of the rock where the female deposited the eggs. Whether it is the male

or the female that sings I am not able to decide, but I did observe that the young when hatched out remained attached to their place of birth—a very remarkable phenomenon. Instead of hatching and liberating themselves in the water, the young emerge and remain still attached to the stones where the eggs have been attached through their development; and not only are the young thus attached for a considerable time, but they are “oriented;” their heads seem to be all turned the same way. These young, like a little army, all point their heads the same way and point their wiggling tails the other way, a very curious and quaint spectacle.

I say we are doubly indebted to Doctor Gill for bringing his very important observations in a condensed form before us at this time, and I think the congress is with me heartily in saying this.

Dr. HUGH M. SMITH (Washington, D. C.). I do not intend to attempt to express my obligations to Doctor Gill for all the encouragement he has given to me and to numerous others with whom I am acquainted, because it would take all the remainder of the session to do that. I simply rise to confirm the statement that Doctor Gill made in regard to oral incubation in certain little fishes, of which I have recently caught a great many in the Philippines. Only a few months ago, while engaged in collecting on a coral reef in the southern part of the Philippine Archipelago, we exploded half a stick of dynamite, and as a result of that one discharge we actually collected 800 specimens, representing nine species of the genus *Apogon*, or *Amia*, as it is now called; and, as far as I was able to see at the time, in each of these species the male fishes had their mouths crammed with eggs. [Applause.]

Dr. TARLETON H. BEAN (New York). Just a word with reference to the remarks of Professor Prince concerning the toadfish of the west coast. Professor Prince doubtless is aware, and, I dare say, it has been brought out in this conference, that the reason for the attachment of the young toadfish, *Opsanus*, or *Porichthys*, as the case may be, is the presence of a ventral disk which is similar to the ventral disk of the lump-fishes, but which disappears, in *Opsanus* at least, after the fish has reached the length of about three-quarters of an inch. I have often collected the little fellows, and have been extremely interested in observing how it was that they remained attached, not only to their place of shelter, but to the place at which they derive their first supply of food. [Applause.]

The ACTING CHAIRMAN (Doctor Gill). Are there any further remarks? If there are no further remarks, I beg to thank the president and the gentlemen for their kindly expressions.

But a few words with reference to the subject at issue. I was very glad to hear Professor Prince make his remarks about the toadfish of Pacific waters, for it tallies very well with the habits of the species of our eastern coast (*Opsanus*). The species, however different externally, are rather closely related; that is, they belong to the same subfamily but to very different genera; and Professor Prince is the first one who has given the details respecting the species of the west coast (*Porichthys*). The habits of our eastern species have been long known. They were described more than a quarter of a century ago by Doctor Ryder, who gave illustrations of the adhesion of the eggs to blocks of wood, and also maintained that the young were attached in the same way during the early condition of life.